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ABSTRACT

The National Assessment Governing Board (NAGB) of the National Assessment of Educational Progress (NAEP) adopted mathematics achievement standards on May 11, 1991 that will be used to report results on the 1990 assessment of mathematics. NAEP achievement levels are descriptions, based on informed judgments, of what students should know and be able to do at grades 4, 8, and 12. The levels for 1990 mark the first time the NAEP has set benchmarks for determining how well students performed, rather than simply reporting how they performed. Three achievement levels, Basic, Proficient, and Advanced, are defined for each of the three grades tested. These levels are defined, and nine sample test items are provided. The Proficient level corresponds with the national goal for student achievement. These levels were defined over an 18-month period with the assistance of approximately 700 judges. The results of the 1990 mathematics tests will be used to assess the utility of achievement levels for mathematics, reading, and writing for the 1992 assessments. (SLD)

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NAGB SETS STANDARDS FOR THE 1990 NAEP MATHEMATICS ASSESSMENT

National Assessment Governing Board Bulletin, June 1991

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National Assessment Governing Board

BULLETIN

National Assessment of Educational Progress

June 1991

NAGB SETS STANDARDS FOR THE 1990 NAEP MATHEMATICS ASSESSMENT

The National Assessment Governing Board (NAGB) on May 11, 1991 adopted mathematics achievement levels. These achievement levels will be used to report results on the 1990 National Assessment of mathematics. The levels will be useful in interpreting how well American students perform .

"States that use achievement levels will have a new tool for monitoring their progress in improving student outcomes across the range of performance."

Richard Boyd
NAGB Chairman

Since its inception in 1969, the National Assessment of Educational Progress (NAEP) has reported regularly on the performance of American students in reading, writing, mathematics, science and history; NAEP has also conducted assessments in other subjects, such as the arts, civics and geography.

NAEP is the Nation's only continuing assessment of student performance capable of reporting nationally representative results.

On a trial basis, NAEP reported state-representative results beginning with the 1990 assessment of 8th grade mathematics, and will continue in 1992 with the 4th grade reading and 4th and 8th grade mathematics assessments.

WHAT ARE NAEP ACHIEVEMENT LEVELS?

Achievement levels are descriptions, based on informed judgments, of what students should know and be able to do at grades 4, 8, and 12, as measured by NAEP.

In 1988, the Congress established NAGB to set policy for NAEP. It also made NAGB responsible for "identifying appropriate achievement goals for each age and grade in each subject area to be tested under the National Assessment." In setting achievement levels for reporting results on the 1990 mathematics assessment, it will for the first time be possible for educators, policymakers, parents, and lay citizens alike to use a common standard for interpreting American student mathematics performance on NAEP.

Achievement Levels

Basic
Denotes partial mastery of the knowledge and skills that are fundamental for proficient work in grades 4, 8, and 12.

Proficient
Represents solid academic performance and competency over challenging subject matter.

Advanced
Represents superior performance beyond proficient grade-level mastery.

In the past, NAEP reports only described how students performed, without benchmarks for determining how well they performed. For instance, early NAEP reports listed each test item and reported the percentage of students with correct responses. More recently, NAEP has reported results on a single cross-grade scale, from 0 to 500, with levels typically defined at 50-point intervals. Thus, NAEP might report that 20% of fourth graders and 40% of eighth graders are able to convert a decimal to a fraction, or that 50% reach the 250 level on the science scale. But without an external standard by which to judge whether these results represent good or poor performance at a particular grade level, interpretations are left to the individual reader.

For each of the three grades tested, there are three achievement levels: Basic, Proficient, and Advanced. These levels are described in more detail and with representative items from the 1990 NAEP math assessment on the following pages.

"The use of achievement levels for reporting NAEP results will help move this Nation to examine seriously the state of our schools and to take decisive action toward improvement."

William Randall
NAGB Member

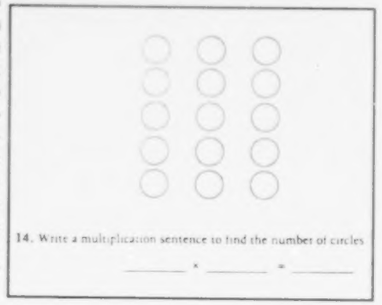
Continued on page 4

TM017227

NAEP 1990 MATHEMATICS ACHIEVEMENT LEVELS--DESCRIPTIONS AND SAMPLE ITEMS

Grade 4 BASIC

Fourth grade students who are performing at the basic level should be able to solve routine one-etep problems involving whole numbers with and without the use of a calculator. They should also be able to use physical materials and pictures to help them understand and explain mathematical concepts and procedures. Students at this level are beginning to develop estimation skills in measurement and number situations and should understand the meaning of whole number operations. For example, students performing at the basic level should be able to link the meaning of multiplication with the symbols needed to represent it. These students are also beginning to develop concepts related to fractions and read simple measurement instruments. Basic fourth grade students should also be able to identify simple geometric figures and extend simple patterns involving geometric figures. These students should be able to read and use information from simple bar graphs.



14. Write a multiplication sentence to find the number of circles.

_____ × _____ = _____

Grade 8 BASIC

The eighth grade student performing at the basic level should be able to identify and use the correct operations for solving one- and two-step problems involving addition, subtraction, multiplication, and division of whole numbers and decimals. These students should also have an understanding of place value and order of operations, and a conceptual understanding of fractions. They should be able to use a calculator and estimation to arrive at answers to simple problems. Basic eighth grade students can use rulers to calculate the perimeter and area of rectangular figures, and make conversions between units of measure within a given system of measurement. These students should be able to use basic geometric terms and identify elementary geometric figures. They should be able to read, interpret and construct bar graphs and evaluate or solve simple linear equations involving whole numbers.

7. What is the value of $n + 5$ when $n = 3$?

Answer: _____

Grade 12 BASIC

Twelfth grade students who are performing at the basic level should demonstrate conceptual and procedural understanding of whole numbers, integers, fractions, and decimals and use them when solving routine problems. They should understand and apply measurement concepts and skills, including estimation, and solve routine problems involving time, money, and length. They should also be able to read scale drawings and use formulas to find areas and volumes. Basic twelfth grade students should be able to identify a wide range of geometric figures, describe their characteristics, and solve problems involving angle measurements and similar triangles. These students should be able to interpret data in a variety of settings, including charts, tables, and graphs. Their understanding of chance should include the ability to select favorable outcomes to a situation and find the probability of an event in a setting involving a small number of outcomes. They should also be able to simplify and evaluate simple linear expressions and solve simple one-step linear equations and inequalities.

9. $2x + 3y + 4x =$

(A) $9xy$

(B) $9x^2y$

(C) $5xy + 4x$

(D) $6x + 3y$

(E) I don't know

Grade 4 PROFICIENT

Fourth grade students who are performing at the proficient level should have an understanding of numbers and their application to situations from students' daily lives. The proficient student should be able to solve a wide variety of mathematical problems; use patterns and relationships to analyze mathematical situations; relate physical materials, pictures, and diagrams to mathematical ideas; and find and use relevant information in problem solving. Fourth grade proficient students should understand numbers and concepts of place value and have an understanding of whole number operations, as well as a facility with whole number computation. For example, students should be able to solve problems with a calculator and have the ability to use estimation skills to solve problems. Proficient fourth grade students should understand and use measurement concepts such as length; be able to collect, interpret, and display data; and use simple measurement instruments.

6. In the figure above, points labeled A through G are spaced evenly along a line. Which of the following distances is the greatest?

(A) From A to D

(B) From C to F

(C) From E to G

(D) From E to A

Grade 8 PROFICIENT

Students at the proficient level should be able, with and without a calculator, to solve problems requiring decimals, fractions, and proportions. They should be able to compute with integers. They should be able to classify geometric figures based on their properties. Proficient eighth grade students should be able to read, interpret, and construct line and circle graphs and show understanding of the basic concepts of probability. These students should be able to translate verbal problem situations into simple algebraic expressions and identify symbolic algebraic expressions representing linear situations.

10. The cost to rent a motorbike is given by the following formula:

Cost = ($3 × number of hours) + $2

Fill in the table below.

Time in Hours	Cost in Dollars
1	5
4	
	17

Did you use the calculator on this question?

○ Yes ○ No

Grade 12 PROFICIENT

Twelfth grade students who are performing at the proficient level should have considerable command of the use of number and operations involving all forms of real numbers. In particular, these students should be able to represent problems involving integers, decimals, and fractions using symbols or graphs. These students should also be able to select, interpret, and use measurement relationships and formulas in problem situations. They should be able to make and evaluate conjectures about the properties of geometric figures. Proficient twelfth grade students should be able to relate data about chance to physical models and use such models to solve problems. These students should be able to use coordinate systems on a number line to represent solutions to one-variable inequalities and use ordered pairs to describe locations in the plane.

16. How many integers are there between $\sqrt{15}$ and $\sqrt{63}$?

(A) Three

(B) Four

(C) Five

(D) Six

(E) Seven

Did you use the calculator on this question?

○ Yes ○ No

Grade 4 ADVANCED

Fourth grade students who are performing at the advanced level should be able to demonstrate flexibility in solving problems and relating knowledge to new situations. They should be able to use whole numbers to analyze more complex problems. Their understanding of fractions and decimals should extend to a number of representations. Students at this level should determine when estimation or calculator use is an appropriate solution to a problem, as well as read and interpret complex graphs. Advanced fourth grade students should also be able to use measuring instruments in non-routine ways. These students should be able to solve simple problems involving geometric concepts and chance.

18. Which decimal represents the shaded part of the figure?

(A) 0.5

(B) 0.28

(C) 0.2

(D) 0.02

Grade 8 ADVANCED

Eighth grade students performing at the advanced level should be able to solve, with and without a calculator, a wide range of practical problems involving percents, proportions, and exponents. These students should have a solid conceptual understanding of the interrelationships among fractions, decimals, and percents and their connections with proportions. Eighth grade advanced students should also understand and be able to use scale drawings, metric measurements, volume, and accuracy of measurement. These students should be able to solve problems involving elementary concepts of probability, interpret line graphs, and apply basic geometric properties related to triangles and to perpendicular and parallel lines.

15. The length of a rectangle is 3 more than its width. If L represents the length, what is an expression for the width?

(A) $3 - L$

(B) $L - 3$

(C) $L \times 3$

(D) $L + 3$

(E) $L - 3$

Grade 12 ADVANCED

Twelfth grade students who are performing at the advanced level should be able to investigate numerical relationships and determine the validity of conjectures involving number theory concepts such as parity (odd, even) and divisibility. These students should be able to establish procedures for the comparison and conversion of measurements of length, area, volume, and capacity. These students should understand the Pythagorean theorem and its applications, as well as use of coordinate geometry to represent relationships and solve problems. These students should also be able to graphically describe data for a situation, as well as provide numerical measures of central tendency (mean, median, and mode) and variability. Advanced twelfth grade students should be able to apply probability and statistics concepts in reasoning about population characteristics based on information derived from a sample, including judging the adequacy of the sample. They should also be able to determine the probability of diverse events. These students should be able to translate information about linear situations from verbal or tabular forms to equations, and analyze, verbally or in writing, the nature of relationships involving change in the values of the variables involved. These students should also be able to solve linear equations, inequalities, and systems of two equations in two variables, as well as evaluate a linear function and relate the value to a point on a graph of the function.

20. Suppose that $a_1, a_2, a_3, \ldots$ is the sequence of numbers such that $a_1 = 3$, $a_2 = \sqrt{a_1 + 1}$, $a_3 = \sqrt{a_2 + 1}$, and, in general, $a_{n+1} = \sqrt{a_n + 1}$ for all $n \geq 1$. To the nearest hundredth, the value of a_5 is

(A) 1.63

(B) 2.62

(C) 2.73

(D) 3.24

(E) 5.73

Did you use the calculator on this question?

○ Yes ○ No

These judgments of what students should know and be able to do at the three grades have several potential advantages over present NAEP reporting procedures.

First, the "Proficient" level intentionally corresponds with the National Educational Goal for student achievement, adopted by the President and the Governors; thus NAEP will have enhanced utility for monitoring and reporting progress toward that goal.

Second, having three levels permits better monitoring of the distribution of performance within the three grades tested by NAEP; this will help focus attention on the students with the greatest needs.

Third, achievement levels will allow states to set and monitor their own targets for improvement.

HOW WERE ACHIEVEMENT LEVELS DEVELOPED?

NAGB set the achievement levels after an extensive process of planning, information gathering, and deliberation. The achievement levels for the 1990 NAEP math assessment were arrived at over an eighteen-month period.

"Setting achievement levels is a judgment call, which the Board made after months of study and with considerable advice from teachers, test experts, and the public."

Michael Glode
Chair, NAGB
Achievement Levels
Committee

NAGB designed the process with the help of distinguished experts in standard setting, psychometrics, and statistics. Over the course of the project, three public hearings were held to obtain ideas and suggestions, to review work-in-progress, and to comment on the achievement levels in draft form. Three separate groups have reviewed and evaluated the process. This landmark effort in standard setting has been open and well-documented.

Approximately 270 judges worked about 4,000 hours to advise on the levels. Most of the judges were mathematics teachers representative of urban, suburban and rural school districts. Parents, business representatives, curriculum and testing experts, and members of the general public participated as well.

The judges were divided into separate groups by grade level of the test (i.e. 4th, 8th and 12th). Judges rated items on the 1990 NAEP mathematics assessment for their grade level. For each item, the judges assigned three scores to indicate the percentage of students at the "Basic," "Proficient," and "Advanced" levels who should answer the item correctly. From these item scores, an average total percent correct score was computed for each of the three achievement levels for all three grades--a total of nine levels in all.

A panel of mathematics specialists was then convened to develop descriptions for each achievement level based on the judges' ratings of the items. The descriptions explain what students at each achievement level should know and be able to do in mathematics as measured by the 1990 NAEP assessment.

NAGB has considered all of this information in making its decision on achievement levels for the 1990 NAEP mathematics assessment. This decision, ultimately, represents a judgment made by NAGB, albeit informed by considerable outside advice and extensive deliberation.

NAGB believes that it has exercised its judgment prudently. However, evaluation will continue through the release of the 1990 mathematics results to assess the utility of achievement levels in interpreting NAEP results. Setting achievement levels in mathematics, reading, and writing for the 1992 assessments will be guided by information gained from the use of the 1990 math levels.

WHEN WILL 1990 MATH RESULTS BE REPORTED USING ACHIEVEMENT LEVELS?

At its August 2-3 meeting, NAGB will make a final decision on the plan for the release of achievement level results. It is likely that the report will be released in late summer or fall.

The National Assessment Governing Board was established by Congress in 1988 to set policy for the National Assessment of Educational Progress, which has been measuring achievement in the Nation's schools since 1969. The 24-member board, appointed by the Secretary of Education, is composed of state, local, and federal officials, educators, and members of the public.

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